DOCUMENT RESUME

ED 169 446 CG 013 392

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TITLE	Behavioral Analysis and Modification of Drug Abuse.
SPONS AGENCY	Public Health Service (DHEW), Arlington, Va.
PUB DATE	Aug 78
GRANT	DA-01472; DA-01943
NOTE	14p.; Paper presented at the Annual Convention of the American Psychological Association (86th, Toronto, Ontario, Canada, August, 1978); Best copy available
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Behavioral Science Research; *Behavior Change; Behavior Patterns; *Contingency Management; *Drug Abuse; *Drug Addiction; Patients (Persons); Research Projects; *Self Control; *Self Evaluation
IDENTIFIERS	*Methadone

ABSTRACT

Some of the unique characteristics of the drug abuse field which distinguish it from the other varieties of substance abuse and research methodologies for studying determinants of drug self-administration behavior which have been developed in response to these characteristics were investigated. Data suggest that residential drug self-administration laboratories are useful contexts for direct observation and measurement of drug self-administration behavior and assessment of experimentally manipulated environmental influences, and methadone maintenance treatment clinics provide settings for applied research on environmental determinants of drug self-administration. Results presented from a sequential group of studies in this setting indicate that contingent reinforcement procedures reduce supplementary drug self-administration by methadone patients. (Author)

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BEHAVIORAL ANALYSIS AND MODIFICATION OF DRUG ABUSE*

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This symposium has the general theme of substance abuse, and the purpose of reviewing the progress and the current status of treatment and research efforts among the various substance abuse fields -- alcoholism, drug abuse, cigarette smoking, and overeating. In light of that theme this paper will begin by commenting upon some of the unique characteristics of the drug abuse field -- characteristics which distinguish it to some extent from the other varieties of substance abuse. In reviewing the literature concerning behavioral approaches to drug abuse (e.g., Götestam et al., 1976) perhaps the most striking fact is the virtual total absence of experimentally controlled behavioral treatment studies in the drug abuse area. This is certainly in contrast to the other varieties of substance abuse, where a number of controlled behavioral treatment studies have been reported. There are two aspects of the drug abuse field which may account, in substantial measure, for this absence of controlled behavioral studies: 1) drug abuse is an illegal behavior; and 2) treatment in the drug abuse field has had a much stronger pharmacological emphasis than has treatment of other varieties of substance abuse.

Illegality

One consequence of the illegality of drug abuse is that the population of drug abusers are, on the whole, a much more deviant population than are other varieties of substance abusers. The illegality of drug abuse probably both selectively screens for deviant individuals and also tends to produce a social climate which induces further deviance from the general population. Thus, drug abuse patients very frequently have a wide range of collateral behavioral problems in addition to their drug use; these other problems and behavioral deficits often include psychiatric disturbances, criminal activities, educational deficits, occupational deficits, marital problems, social skills deficits, etc. Because of the extent and severity of these common collateral behavioral problems there has often been a tendency to

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*Presented at the annual meeting of the American Psychological Association, Toronto, Canada, September 1978. This research and paper preparation were supported by USPHS research grants DA-01472 and DA-01943 and by Research Scientist Development Award DA-00050.

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treat these other behavioral problems and to consider them to be the "real" drug abuse problem. There have been some controlled behavioral studies which have focused upon these collateral behavioral problems among drug abusers (e.g., Hall et al., 1977). However, I would suggest that attending to the collateral behavioral problems and deficits of drug abusers actually serves to divert our attention away from the phenomenon of drug abuse itself. In our own work and for purposes of the present discussion I would maintain that the behavior of drug self-administration is the central defining behavioral element in drug abuse. There are certainly many interesting questions to be asked concerning the relationship between drug self-administration and various collateral behaviors: i.e., do alterations in collateral behaviors result in alterations in drug self-administration? Do alterations in drug self-administration result in consequent alterations in collateral behaviors? But to the extent that our investigations focus solely upon the measurement and alteration of collateral behaviors we lose information about the phenomenon of drug abuse and become involved in the study and treatment of the drug abuser.

A second consequence of the illegality of drug abuse which has also contributed to the tendency to study collateral behaviors instead of drug self-administration itself is that because it is illegal the behavior of drug self-administration is rarely observed clinically. The behavior of drug self-administration typically occurs in settings from which therapists and investigators are excluded. The other varieties of substance abuse -- cigarette smoking, alcohol consumption, and food consumption -- are all socially common and widely observed. In fact, no doubt many of us have frequently observed all three of these other varieties of substance abuse occurring concurrently or in quick succession in the same individual. However, very rarely if every have any of us observed intravenous narcotic self-administration. Even in the clinical treatment of drug abuse the only objective indicator of drug use available is urinalysis, which provides only a qualitative response (yes or no some unknown amount of drug has been taken within the several-day period preceding the urine sample) and often after a considerable delay (several days or even weeks may elapse from the submission of the urine sample until the receipt of urinalysis results from the laboratory). Certainly, this relative difficulty of observing and measuring the extent of drug self-administration has contributed to the diversion of research attentions away from drug self-administration behavior and to some of the more readily observable and more readily measurable collateral behaviors which are so evident among the drug abuse population.

Pharmacological Emphasis

To a greater extent than with the other varieties of substance abuse the treatment of drug abuse has received an overwhelmingly pharmacological emphasis. The treatment of drug abuse has been more likely to fall into the hands of physicians, and there has been a greater attention paid to such pharmacological processes as physiological addiction, detoxification techniques, and treatment with substitute drugs. This latter emphasis is especially evident in the widespread involvement and attention paid to

such techniques as methadone maintenance and the development of narcotic antagonist drugs. This pharmacological/medical dominance in the drug abuse treatment area has produced a situation in which drug abuse has been relatively inaccessible to the behavioral scientist for research and treatment.

CONTEXTS FOR BEHAVIORAL STUDY OF DRUG SELF-ADMINISTRATION

The forces discussed above, which have limited the extent of behavioral research on drug abuse, have also acted to shape the development of research contexts within which the behavior of drug self-administration by drug abusers can be studied. Below are described two of the major contexts developed for such work, along with examples of the types of research being conducted in each.

Residential Drug Self-Administration Laboratories

The difficulty of observing and measuring drug self-administration behavior clinically has led to the development of a very specialized research environment for accomplishing this end -- residential human drug self-administration laboratories. These environments bring the behavior of drug self-administration into the laboratory for direct observation and measurement. These laboratories typically study as research participants individuals with histories of chronic illicit drug abuse who are given access to limited quantities of their drug under controlled experimental conditions. We have previously reviewed the methodological development of these laboratory procedures (Bigelow et al., 1975a, 1975b). The controlled laboratory environment permits the experimental manipulation of the conditions of drug availability so as to permit examination of causal influences upon drug self-administration. Since participants in these studies are individuals who have already developed a strong repertoire of excessive drug self-administration, these laboratories are able to study variables which influence the maintenance of self-administration by abusers and also to study variables which might reduce drug self-administration by drug abusers -- i.e., treatment analogue studies.

Figure 1 shows the results of one such treatment analogue study reported by Jones and Prada (1975). This study examined the effect of methadone maintenance treatment upon opiate self-administration by narcotic abusers, and was conducted within the NIDA Addiction Research Center in Lexington, Kentucky. Six volunteers were given the opportunity three times per week to earn 4-mg intravenous doses of hydromorphone (Dilaudid) by riding a stationary exercise bicycle. Following a baseline period methadone maintenance was initiated, with the daily dose being gradually increased to a stable level of 100 mg daily; the average daily methadone dose is shown in the bottom panel of the figure. The panel directly above shows the number of subjects riding for and receiving intravenous hydromorphone injections on each opportunity. As can be seen, virtually all available

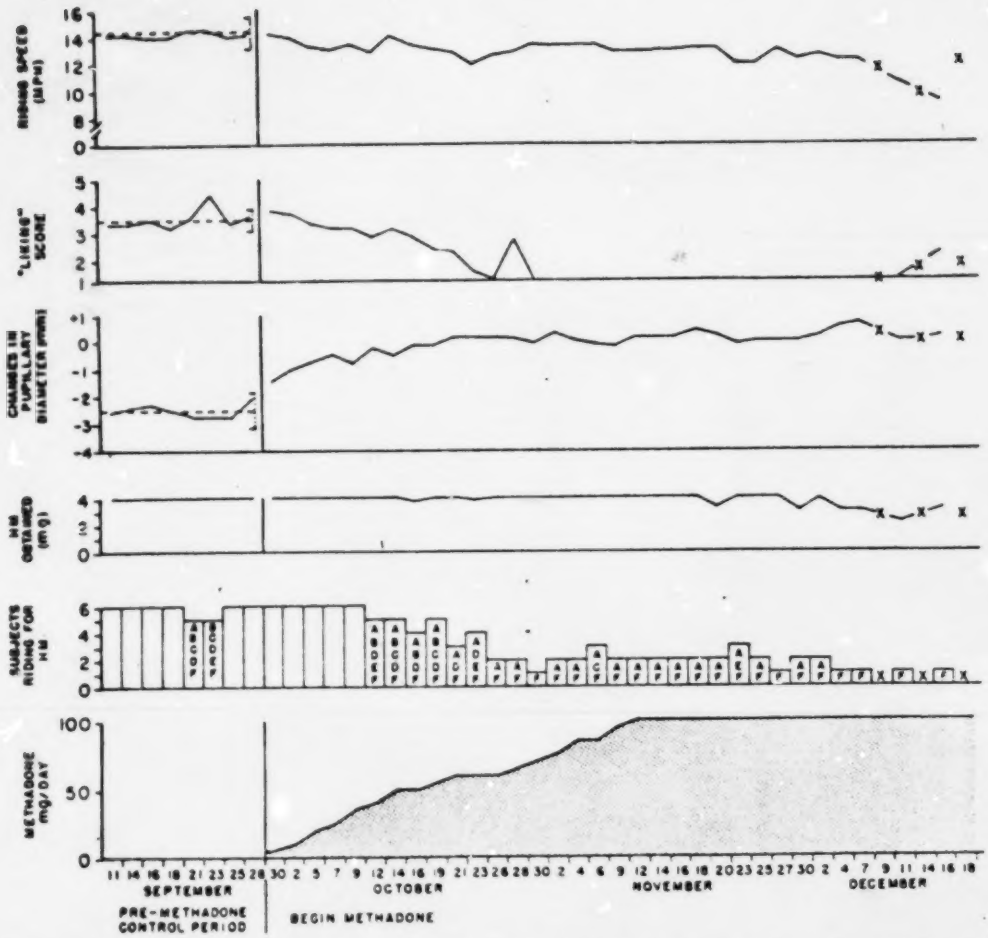

Fig. 1. Days on which hydromorphone (*HM*) was available and number of subjects who rode exercise bicycle on those days, with mean values for subjects who rode on a particular day for amount of hydromorphone obtained and riding speed, and pupillary change and "liking" score in response to hydromorphone. Mean amount of methadone received daily is for all 6 subjects. Letters within the subjects columns indicate which subjects rode on a particular day when not all of the subjects rode. An *X* indicates days on which hydromorphone was available but no subjects rode. For change in pupillary diameter, "liking" score, and riding speed, the means and 95% confidence limits for the pre-methadone control period are shown by dashed lines. Note that for all parameters except daily methadone the number of subjects upon which the observations are based decreases across time

Figure 1

hydromorphone was self-administered prior to methadone maintenance, and this self-administration persisted while daily methadone dose rose to approximately 50 mg; hydromorphone self-administration declined as daily methadone dose rose above 50 mg. Interestingly, however, methadone maintenance did not totally abolish intravenous narcotic self-administration. It is especially interesting to note that some self-administration persisted even though these injections produced no measurable effects on either participants' subjective "liking" response (panel 2) or upon participants' physiological status (panel 3). These laboratory findings generally confirm clinical experience -- methadone maintenance is effective in reducing intravenous narcotic use, however it does not totally eliminate such behavior. The persistence of some degree of narcotic self-administration during methadone maintenance and the absence of subjective or physiological

drug effects serves, I think, to emphasize the nature of drug abuse as a complex behavioral phenomenon with many historical and environmental determinants beyond mere pharmacological drug reinforcement.

Figure 2 shows data from a second example of the use of residential drug self-administration laboratories to conduct an analogue evaluation of the effects of a pharmacological treatment technique for narcotics addiction -- the use of narcotic antagonist drugs. In this study by Meyer et al. (1976) narcotic abusers were given the opportunity to self-administer heroin intravenously in the laboratory for 10-day periods. To allow for the development of physiological tolerance a progressive heroin dosage ceiling was scheduled across the 10-day self-administration periods. On some occasions these heroin self-administration periods were scheduled to occur during blockade by a narcotic antagonist (e.g., naltrexone 75 mg orally per day), and at times without narcotic blockade. The figure shows data for one representative subject who was exposed to both the blocked (bottom panel) and unblocked (top panel) conditions. The solid lines show the dosage ceiling across consecutive days, and the open circles show the amount of self-administration. As can be seen, under the unblocked condition heroin self-administration was near maximal; under the condition of blockade by narcotic antagonist heroin self-administration was reduced to zero or near-zero levels. These data are compatible with clinical experience with narcotic antagonists indicating that antagonist treatment does reduce illicit narcotic self-administration. Interestingly, these laboratory data show that during narcotic antagonist treatment the phenomenon of operant extinction of drug self-administration behavior which it had been hoped would occur during antagonist treatment in fact does not occur; instead of the gradual reduction in heroin self-administration which one would expect if operant extinction were operating, one sees an immediate abrupt elimination of heroin self-administration by narcotic antagonists.

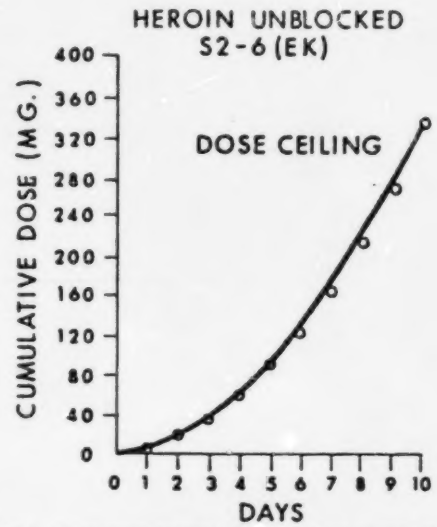

Fig 1.—Heroin acquisition behavior of one subject representative of all subjects during the unblocked (top) or blocked (bottom) heroin phase. Doses are plotted cumulatively over days.

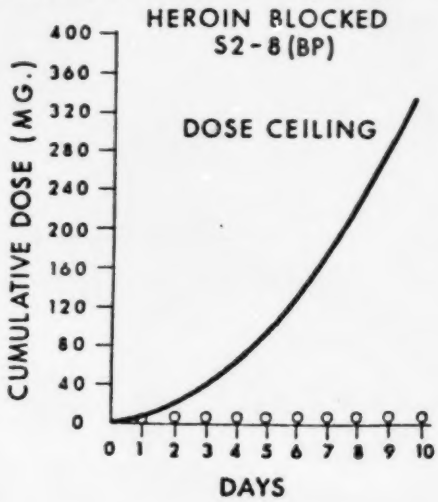

Figure 2

One of the most ubiquitous and troubling problems in the field of substance abuse is that of relapse. Relapse rates are extremely high for all of the substance abuse disorders, and developing techniques for understanding the determinants of relapse and thereby preventing it is of high priority. Relapse has been an extremely difficult phenomenon to study since it so commonly occurs after the discontinuation of treatment contact. We have recently been attempting to use the residential drug self-administration laboratory setting as a context within which to develop and study experimental models of the relapse phenomenon. In these studies methadone maintenance patients wishing to detoxify are permitted to self-regulate their methadone detoxification within the context of a methadone self-administration experiment in the residential laboratory. It is hoped that examination within the laboratory of environmental correlates of self-administered methadone dose increases will yield information concerning determinants of relapse. This research procedure is still in its developmental stages and we have as yet no substantive data to report. Figure 3 presents data from two recent participants (Bigelow et al., 1978), and shows concurrently for each individual across consecutive days the patients' self-administered methadone doses (filled circles) and the patients' subjective symptoms according to a daily self-report form (open squares show the total symptom score, and open triangles show the score on the cluster of opiate withdrawal items). The main thing to note in these data is that these patients given self-control of their methadone intake do progressively reduce their daily drug intake, and that they continue to do so despite increasing subjective symptomatology related to the methadone withdrawal. Thus, the appearance of withdrawal symptomatology is not in itself sufficient to produce relapse to voluntary narcotic self-administration. We hope that as we proceed with the use of this methodology we will be able to identify some factors related to either increasing or decreasing the probability of relapse to narcotic self-administration.

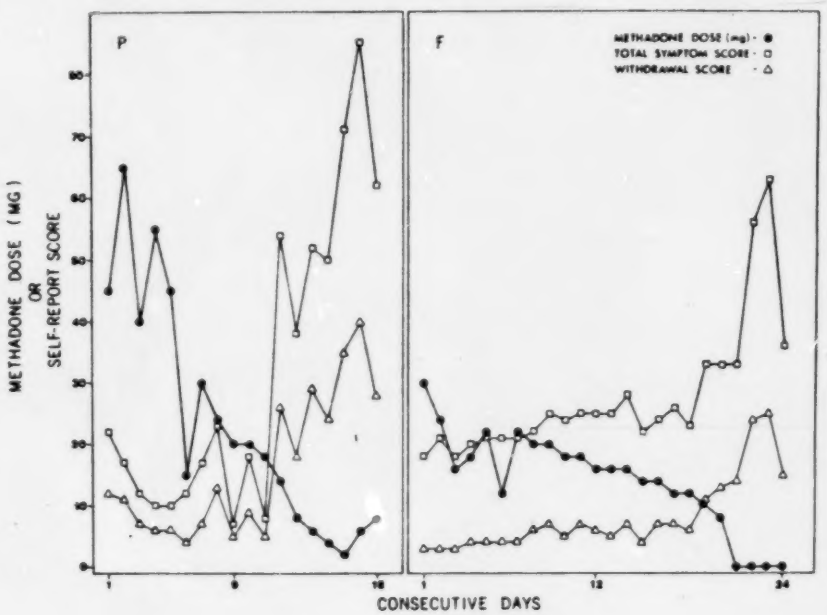

Figure 3

Methadone Maintenance Treatment Clinics

Despite the fact that to some extent methadone maintenance has placed addiction treatment into a medical model and has tended to make it relatively inaccessible to the behavioral scientist, it is also true that the existence of methadone maintenance clinics can be used to advantage to gain access to a drug-abusing population for behavioral treatment and research purposes. From a behavioral perspective perhaps the most important aspect of methadone maintenance treatment is that it involves the routine dispensing of a potent reinforcer to addicts. Consequently, methadone maintenance treatment is popular with addicts; in contrast to other varieties of addiction treatment it is even possible to maintain a waiting-list for admission to methadone treatment. The facts that methadone treatment attracts patients and that it requires frequent routine visits to the clinic would seem to make it an ideal context within which to develop and initiate behavioral treatment and research programs concerning addiction.

In our initial work in this area (Bigelow et al., in press) we sought to superimpose upon routine methadone maintenance treatment a 2x2 behavioral treatment evaluation research design with patients being assigned in a mixed order to one of the 4 treatment cells illustrated in Figure 4. In this study contingency management treatment sought to use methadone program privileges such as medication take-home privileges and dose alterations as contingent reinforcers to shape desirable changes in behavior, and behavior therapy treatment sought to use emotionally-based behavior therapy techniques such as desensitization, relaxation training, and biofeedback to reduce undesirable behavioral control exerted by environmental stimuli. This design proved to be too idealistic given the relatively primitive state of our knowledge about behavioral treatment of drug addiction and given the complexity and variability of the methadone treatment situation, and the study provided primarily a learning experience for us as investigators in how more effectively to design and implement behavioral treatment evaluation studies within the methadone maintenance clinic context. Two primary findings shaped our subsequent work in this area: First, the emotionally-based behavior therapy techniques which required relatively greater patient cooperation were generally difficult to implement, whereas contingency management techniques which could be implemented more unilaterally by the treatment staff were easier to implement and appeared in a number of case studies to show evidence of efficacy in modifying patients' behavior in desirable directions;

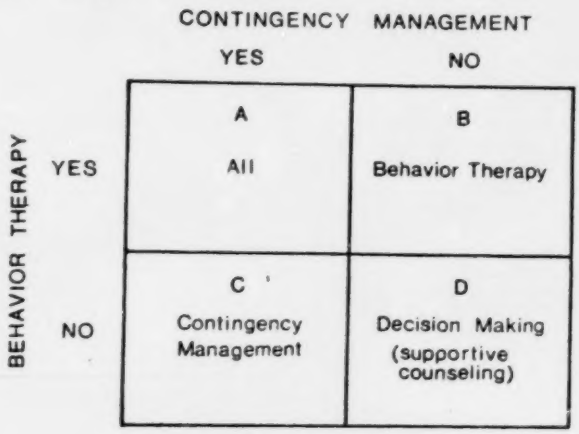

Figure 4

and second, that there is such diversity in presenting problems among methadone maintenance patients that it would be necessary for future behavioral studies to focus very narrowly on specific behavioral outcomes. This latter point is illustrated in Figure 5, which shows the distribution of patients across levels on various outcome measures during the 2-month baseline period preceding the initiation of treatment. The numerals on the right of the figure show the percent of the total patient population who were capable of further improvement or worsening on these different outcome measures; interestingly, we found ourselves conducting narcotics addiction treatment research in a context in which only 40% of the participants were capable of further improvement on the dimension of extent of narcotics use according to our measures. Our subsequent research has been conducted with patients who are initially selected as being homogeneous with respect to displaying a sufficiently high level of the specific behavioral problem upon which the research focuses, and the primary intervention strategy which we have used and evaluated has been that of contingent reinforcement.

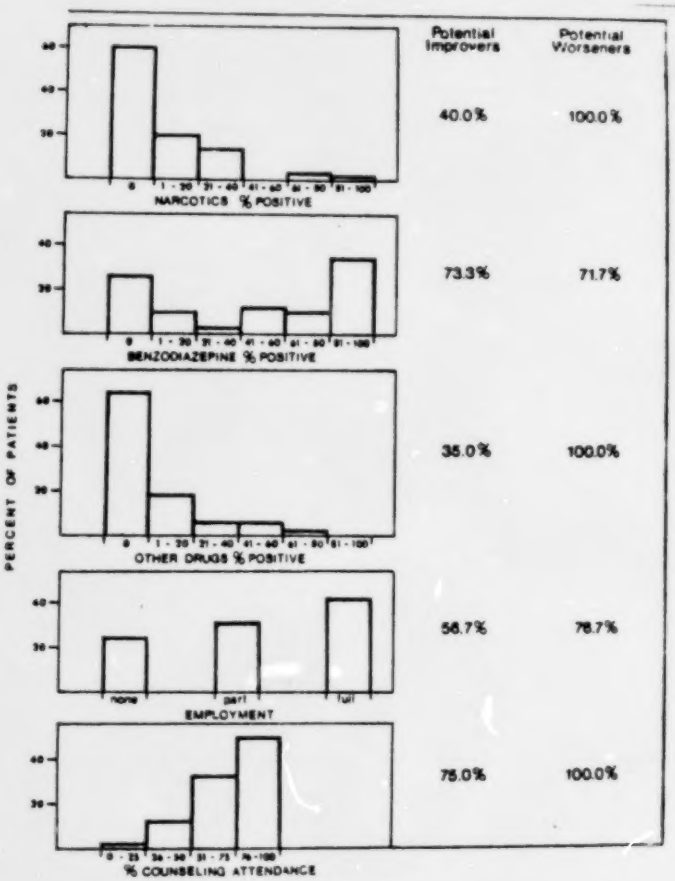

Figure 5

One series of studies by Liebson et al. (1973, 1978) has focused upon the treatment of alcoholism among alcoholic methadone maintenance patients. Alcoholic patients whose drinking was so severe as to threaten their continuation in methadone treatment were offered methadone continuation contingent upon their agreeing to take disulfiram (Antabuse), which induces an aversive reaction if the patient drinks alcohol while maintained on disulfiram. Volunteers were then randomly assigned to a traditional prescription-control condition (in which they were given a supply of disulfiram and encouraged to take it daily) or to the contingent treatment condition (in which daily supervised ingestion of disulfiram at the methadone clinic was a prerequisite to continuation in methadone treatment). Figure 6, which is adapted from Liebson et al. (1978), shows the duration of retention

in treatment of patients assigned to these two conditions. In the contingent treatment condition 11 of 13 patients successfully completed their assigned 6-month treatment duration. In the prescription-control condition only 1 of 10 patients did so, 3 were jailed prior to completion of their 6 months of treatment (2 for drinking-related reasons), and 5 drank so severely before the end of their 6-month treatment that this control treatment procedure was discontinued and the individuals were reassigned to the contingent treatment condition for their own safety. This study demonstrates clearly that access to methadone treatment can be used as a contingent reinforcer to maintain therapeutic behavior by patients

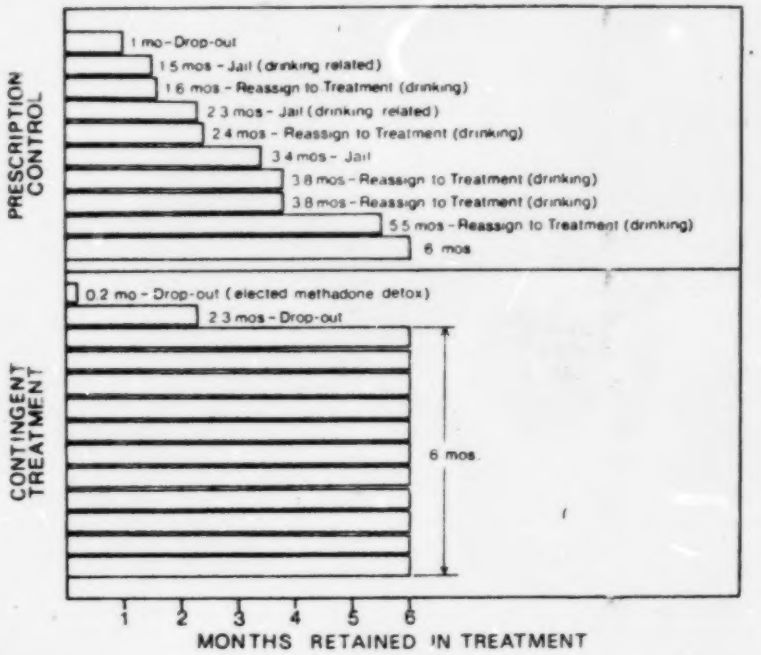
PRESCRIPTION CONTROL
1 mo - Drop-out
1.5 mos - Jail (drinking related)
1.6 mos - Reassign to Treatment (drinking)
2.3 mos - Jail (drinking related)
2.4 mos - Reassign to Treatment (drinking)
3.4 mos - Jail
3.8 mos - Reassign to Treatment (drinking)
3.8 mos - Reassign to Treatment (drinking)
5.5 mos - Reassign to Treatment (drinking)
6 mos
CONTINGENT TREATMENT
0.2 mo - Drop-out (elected methadone detox)
2.3 mos - Drop-out
6 mos.
1 2 3 4 5 6
MONTHS RETAINED IN TREATMENT

Figure 6

Subsequent studies have tried to identify more specific and limited privileges which might be used as reinforcers. In a study reported by Stitzer et al. (1977) we have investigated the efficacy of contingent methadone take-home privileges as a reinforcer to influence addict patients' behavior. In that study a group of patients were selected who normally showed a low rate of counseling session attendance and the effect of offering medication take-home privileges contingent upon counseling session attendance was then evaluated via a within-subject reversal experimental design. These data are presented in Figure 7, which shows the percent of clients attending counseling sessions over consecutive weeks of the study. During the two periods of contingent reinforcement counseling session attendance was high; during the three periods without contingent reinforcement counseling session attendance was low. This study clearly demonstrated the efficacy of contingent reinforcement with methadone take-home privileges for modifying patients' behavior. In subsequent studies we have attempted to utilize

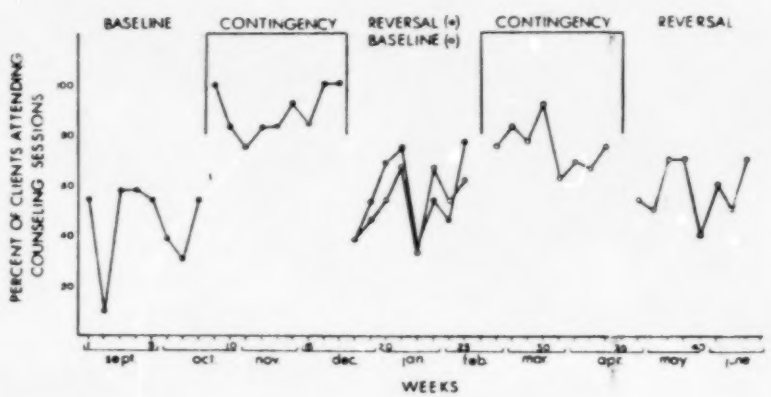

Figure 7

contingent methadone program privileges as reinforcers to modify behaviors of greater clinical relevance than counseling attendance; we have begun to investigate the possibility of using contingent reinforcement with program privileges to modify drug use by addict patients.

In our initial study of contingent reinforcement effects upon addicts' drug self-administration (Stitzer and Bigelow, 1978) we chose for experimental measurement purposes to bring the drug self-administration behavior under direct observation and measurement. This was done by making the supplementary drugs available to patients at the clinic. Participants were selected who were already using supplementary diazepam (Valium(R)) and were informed that since the clinic prefered to substitute prescribed use at the clinic for their current illicit use they would be permitted to request and receive up to 2 10-mg diazepam tablets daily at the clinic. An A-B-A-C-A within-subject experimental design was used, in which A represented baseline periods of diazepam availability and B and C represented periods of contingent reinforcement for refusal of the available diazepam. Two alternative reinforcers were compared -- a one-day methadone take-home privilege, and a one-day opportunity to self-regulate methadone dosage by as much as ± 20 mg. During reinforcement conditions patients could receive up to 2 non-consecutive reinforcements per week by refusing diazepam at the clinic window. The order of exposure to the two different reinforcement conditions was counterbalanced across subjects. The data are shown in Figure 8. During baseline conditions 96% of available diazepam doses were taken by patients; contingent dose self-control reduced this to 69.7%; and contingent take-home privileges reduced this to 11.7%. Thus, both reinforcers show some efficacy in reducing diazepam use, but the contingent take-home medication was much more effective than the contingent dose self-control. Overall, the study shows that contingent methadone clinic privileges can be used to modify the drug self-administration behavior of drug abuse patients.

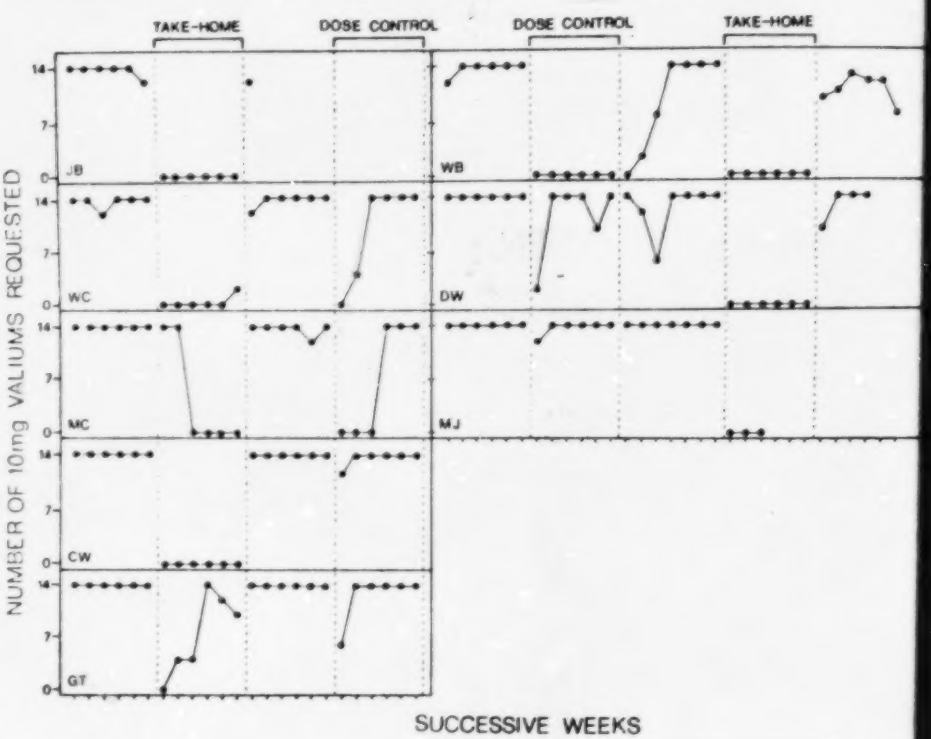

Figure 8

Clinically when one tries to influence drug-taking by addict patients one is not able to observe directly the drug self-administration behavior, but rather must rely upon urinalysis results as indicators of drug use. Therefore, we have extended our studies of contingent reinforcement to procedures which reinforce improved urinalysis results (Stitzer et al., in press). Patients' urine samples are analyzed with an on-site EMIT (enzyme immunoassay technique) urinalysis system, which provides results while the patient waits, in order to minimize delay of reinforcement. Participants have been methadone maintenance patients showing chronic urinalysis evidence of supplementary benzodiazepine use. An A-B-A within-subject experimental design has been used in which a period of contingent reinforcement (typically of 12-week duration) has been interposed between periods of non-reinforcement. Because benzodiazepine metabolites disappear slowly from the body reinforcement was provided contingent upon declining urine concentrations of the benzodiazepine metabolites. Urine samples were collected twice weekly and EMIT values (which correlate with urine concentrations of benzodiazepine metabolites) lower than that for the preceding urine sample (or in the negative category) resulted in reinforcement. Reinforcement resulted in patients being able to choose one of the following: a 1-day methadone take-home privilege, a 1-day opportunity to self-regulate methadone dose (± 20 mg), or $7.50 cash payment. Results are shown in Figure 9, where open circles represent EMIT values during non-contingent periods and closed circles represent EMIT values during contingent reinforcement periods. Dots adjacent to closed circles indicate that reinforcement was received. The horizontal line represents the separation between positive and negative urinalysis results. All patients showed reduced benzodiazepine urinalysis levels during contingent periods. However, these reduced levels were either transitory or sporadic for 3 of the 5 patients. However, overall these data show that reinforcement contingencies based upon urinalysis results can have a marked impact upon supplementary drug use by clients with extensive patterns of supplementary use. Certainly further work needs to be done to improve the effectiveness of these techniques and the duration of their effectiveness.

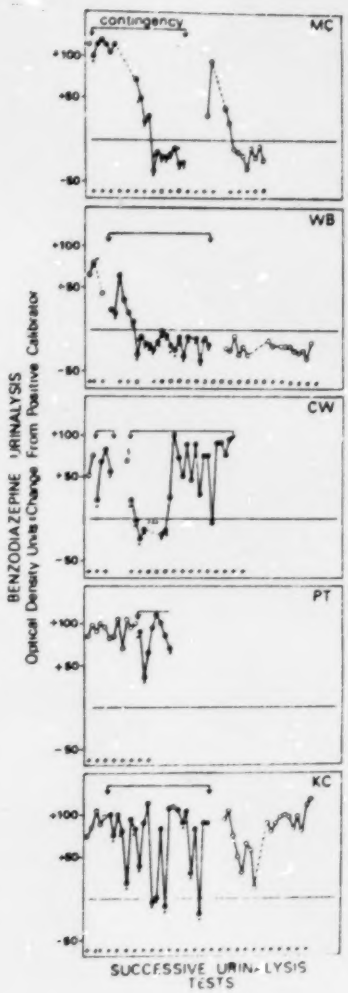

Figure 9

CONCLUSION

In concluding I would like to refer back to the theme of this symposium -- which is to discuss methods and goals of substance abuse research. What I have tried to do in this presentation is to describe some of the unique characteristics of the drug abuse field relative to the other varieties of substance abuse and to show how these characteristics have guided and shaped the methods used to conduct behavioral studies of human drug self-administration. I have described and shown examples of two general methods for bringing drug self-administration by drug abusers under direct experimental study and objective measurement -- the first, is the study of human drug self-administration occurring in the laboratory; second, is the utilization of outpatient drug abuse treatment clinics (especially methadone maintenance clinics) as settings which can permit both experimental interventions and objective measurement of drug use.

In both of these situations the goals of the studies are to develop an empirical basis for understanding the behavioral and pharmacological variables which maintain habitual drug self-administration and for evaluating the impact of interventions intended to reduce habitual drug taking. I think we are still at an early stage in this process, but our hope is that the development and use of these procedures for objective experimental study of human drug self-administration can speed our progress toward effective behavioral treatment of drug abuse.

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